

WHAT IS CLAIMED IS:

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1. A game apparatus with which a player plays a game with virtual object(s) in a mixed reality space comprising:

5           viewpoint detection means for detecting the location/posture of a viewpoint of the player; geometric information acquisition means for acquiring geometric information of real object(s);

            recognition means for recognizing a current,  
10       relative relationship between the virtual object(s) and real object(s);

            a rule memory for storing rules for controlling the action of the virtual object(s);

            computation means for determining the next action  
15       of the virtual object(s) in accordance with the rules stored in said rule memory and in correspondence with the location/posture of the real object(s), and computing the location/posture of the virtual object(s) after the determined action; and

20           presentation means for generating at least one of image of the virtual object on the basis of the location/posture of the virtual object(s) after the action and the location/posture of the viewpoint position of the player, and for representing the mixed  
25       reality space to the player by superimposing the

virtual object image(s) on the player's view of the  
real space.

2. A game apparatus according to claim 1, wherein  
5 said presentation means further comprising,

image-capturing means for capturing real space  
images of said player's view of the real space;

image generation means for generating mixed  
reality images representing of the mixed reality space  
10 by superimposing or overlaying said virtual object  
image(s) on said real space images; and

a video see-through type display means that the  
player wares wherein said mixed reality images are  
displayed.

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3. A game apparatus according to claim 1, wherein  
said presentation means further comprising,

An optical see-through type display means that  
the player wares wherein said virtual object image(s)  
20 are displayed.

4. A game apparatus according to claim 1, further  
comprising,

status detecting means for detecting status of  
25 the player;

wherein said computation means determines a next action of the virtual object in accordance with the rule stored in said rule memory and in correspondence with the location/posture of the real object and/or the status, and computing a location/posture of the virtual object after the determined action.

5. The apparatus according to claim 1, wherein the current, relative relationship includes a layout relationship between the virtual object and real object at that time in the mixed reality space.

6. The apparatus according to claim 1, wherein the current, relative relationship includes a behavior of the real object with respect to the virtual object at that time in the mixed reality space.

7. The apparatus according to claim 1, wherein the real object includes the player himself or herself, and said recognition means recognizes a current, relative relationship between the virtual object and the player.

8. The apparatus according to claim 1, wherein the real object includes a plurality of players who operate said game apparatus, and the plurality of players share a single mixed reality space.

9. The apparatus according to claim 1, wherein the real object is an object which is fixed in position, and

said geometric information acquisition means  
comprises:

a predetermined memory for pre-storing location  
information and shape information of the real object;

5 and

means for reading out the location information  
and shape information of the real object from said  
memory as needed.

10. The apparatus according to claim 1, wherein the  
10 real object is an object which is movable but does not  
deform, and

said geometric information acquisition means  
comprises:

a predetermined memory for pre-storing shape  
15 information of the real object;

a location/posture sensor for detecting a  
location/posture of the real object; and

means for setting a region the real object is  
expected to occupy in the mixed real space in  
20 accordance with the detected location/posture of the  
real object.

11. The apparatus according to claim 1, wherein the  
real object is a player, and

said geometric information acquisition means  
25 comprises:

a sensor for detecting a location/posture of a head of the player; and

means for setting a region having a fixed, known shape that approximates the player in the mixed reality space in accordance with the detected location/posture of the head.

12. The apparatus according to claim 1, wherein when the game is a battle game with the virtual object, an objective is to decrease an expected score of the player.

13. The apparatus according to claim 1, wherein when the game is a cooperative game with the virtual object, an objective is to increase an expected score of the player.

14. The apparatus according to claim 1, wherein the rule controls the action of the virtual object on the basis of an objective of the game and a relative relationship between the virtual object and real object.

15. The apparatus according to claim 1, wherein the rule stored in said rule memory expresses the action of the virtual object as an action pattern with a predetermined aim for achieving the objective.

16. The apparatus according to claim 15, wherein the pattern has a path disadvantageous to the player in consideration of a layout relationship between the virtual object and real object.

17. The apparatus according to claim 11, wherein when the player is one of real objects, an output from said viewpoint detection means for detecting the location/posture of the viewpoint of the player is also  
5 used as information which is to be acquired by said geometric information acquisition means and pertains to a location and shape of the player.

18. The apparatus according to claim 1, wherein said viewpoint detection means detects a location/posture of  
10 a head of the player, and

said apparatus further comprises detection means for detecting a location/posture of a hand of the player; and

means for recognizing a relative location of the  
15 hand of the player with respect to the head as a command on the basis of an output from said detection means.

19. The apparatus according to claim 1, wherein said presentation means comprises:

20 means for aligning the location/posture of the real object to the location/posture of the virtual object after movement;

means for generating an image of the virtual object after alignment in correspondence with an  
25 occlusion relationship; and

a head-mounted display device.

20. An image processing method for a game apparatus with which a player plays a game with virtual object(s) in a mixed reality space comprising:

- viewpoint detection step for detecting the  
5 location/posture of a viewpoint of the player;
- geometric information acquisition step for acquiring geometric information of real object(s);
- recognition step for recognizing a current,  
10 relative relationship between the virtual object(s) and real object(s);
- a rule memory for storing rules for controlling the action of the virtual object(s);
- computation step for determining the next action of the virtual object(s) in accordance with the rules  
15 stored in said rule memory and in correspondence with the location/posture of the real object(s), and computing the location/posture of the virtual object(s) after the determined action; and
- presentation step for generating at least one of  
20 image of the virtual object on the basis of the location/posture of the virtual object(s) after the action and the location/posture of the viewpoint position of the player, and for representing the mixed reality space to the player by superimposing the  
25 virtual object image(s) on the player's view of the real space.

21. The method according to claim 20, wherein the player wears a video see-through type display, and said presentation step further comprising,

image-capturing step for capturing real space  
5 images of said player's view of the real space;  
image generation step for generating mixed  
reality images representing of the mixed reality space  
by superimposing or overlaying said virtual object  
image(s) on said real space images and for displaying  
10 said mixed reality images on the display.

22. The method according to claim 20, wherein the player wears an optical see-through type display and said presentation step representing the mixed reality space to the player by displaying the virtual object  
15 image(s) on the display.

23. The method according to claim 20, further comprising,

status detecting step for detecting status of the player;

20 wherein said computation step determines a next action of the virtual object in accordance with the rule stored in said rule memory and in correspondence with the location/posture of the real object and/or the status, and computing a location/posture of the virtual  
25 object after the determined action.

24. The method according to claim 20, wherein the current, relative relationship includes a layout relationship between the virtual object and real object at that time in the mixed reality space.

5 25. The method according to claim 20, wherein the current, relative relationship includes a behavior of the real object with respect to the virtual object at that time in the mixed reality space.

26. The method according to claim 20, wherein the  
10 real object includes the player himself or herself, and the recognition step includes the step of recognizing a current, relative relationship between the virtual object and the player.

27. The method according to claim 20, wherein the  
15 real object includes a plurality of players who operate the game apparatus, and the plurality of players share a single mixed reality space.

28. The method according to claim 20, wherein the  
20 real object is an object which is fixed in position, and

the geometric information acquisition step includes the steps of:

pre-storing location information and shape information of the real object in a predetermined  
25 memory; and

reading out the location information and shape information of the real object from the memory as needed.

29. The method according to claim 20, wherein the  
5 real object is an object which is movable but does not deform, and

the geometric information acquisition step includes the steps of:

pre-storing shape information of the real object  
10 in a predetermined memory;

detecting a location/posture of the real object by a location/posture sensor; and

setting a region the real object is expected to occupy in the mixed real space in accordance with the  
15 detected location/posture of the real object.

30. The method according to claim 20, wherein the real object is a player, and

the geometric information acquisition step includes the steps of:

20 detecting a location/posture of a head of the player; and

setting a region having a fixed, known shape that approximates the player in the mixed reality space in accordance with the detected location/posture of the  
25 head.

31. The method according to claim 20, wherein when the game is a battle game with the virtual object, an objective is to decrease an expected score of the player.

5 32. The method according to claim 20, wherein when the game is a cooperative game with the virtual object, an objective is to increase an expected score of the player.

33. The method according to claim 20, wherein the  
10 rule controls the action of the virtual object on the basis of an objective of the game and a relative relationship between the virtual object and real object.

34. The method according to claim 20, wherein the  
rule stored in the rule memory expresses the action of  
15 the virtual object as an action pattern with a predetermined aim for achieving the objective.

35. The method according to claim 34, wherein the  
pattern has a path disadvantageous to the player in  
consideration of a layout relationship between the  
20 virtual object and real object.

36. The method according to claim 30, wherein when  
the player is one of real objects, an output from said  
viewpoint detection step of detecting the  
location/posture of the viewpoint of the player is also  
25 used as information which is to be acquired in the

geometric information acquisition step and pertains to a location and shape of the player.

37. The method according to claim 20, wherein the viewpoint detection step includes the step of detecting  
5 a location/posture of a head of the player, and

said method further comprises the detection step of detecting a location/posture of a hand of the player; and

the step of recognizing a relative location of  
10 the hand of the player with respect to the head as a command on the basis of an output in the detection step.

38. The method according to claim 20, wherein the presentation step includes the steps of:

aligning the location/posture of the real object  
15 to the location/posture of the virtual object after movement; and

generating an image of the virtual object after alignment in correspondence with an occlusion relationship.

20 39. A storage medium which stores a program of an image processing method for a game apparatus with which a player plays a game with virtual object(s) in a mixed reality space comprising:

viewpoint detection program step for detecting  
25 the location/posture of a viewpoint of the player;

geometric information acquisition program step  
for acquiring geometric information of real object(s);

recognition program step for recognizing a  
current, relative relationship between the virtual  
5 object(s) and real object(s);

a rule memory for storing rules for controlling  
the action of the virtual object(s);

computation program step for determining the next  
action of the virtual object(s) in accordance with the  
10 rules stored in said rule memory and in correspondence  
with the location/posture of the real object(s), and  
computing the location/posture of the virtual  
object(s) after the determined action; and

presentation program step for generating at least  
15 one of image of the virtual object on the basis of the  
location/posture of the virtual object(s) after the  
action and the location/posture of the viewpoint  
position of the player, and for representing the mixed  
reality space to the player by superimposing the  
20 virtual object image(s) on the player's view of the  
real space.